A simulation of the effect of TWD (tool wear per discharge) estimation error on the depth of machined surfaces in micro-EDM milling

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A simulation of the effect of TWD (tool wear per discharge) estimation error on the depth of machined surfaces in micro-EDM milling

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Abstract

In micro-EDM milling, real time electrode wear compensation based on tool wear per discharge (TWD) estimation permits the direct control of the position of the tool electrode frontal surface. However, TWD estimation errors will generate a self-amplifying error on the tool electrode axial depth. A simulation tool is developed to calculate the effects of errors in the initial estimation of TWD and its propagation effect with respect to the error on the depth of the cavity generated. Simulations were applied to micro-EDM milling of a slot of 5000 µm length and 50 µm depth, with a segment length of 100 µm and layer thickness of 1 µm, and TWD estimation errors ranging from -10% to +10%. In order to validate the results obtained using simulations, slot milling experiments were performed on a SARIX SX-200 micro-EDM machine with tungsten carbide tool electrodes and Stavax steel workpieces. Simulations and experimental results show that with a variation in TWD estimation error from +1% to +5%, the maximum error in the geometry of micro-EDM milled profile varied from +6.14% to +40.52%. The results of depth predicted using the simulation and the average depth obtained using experiments were found to agree well within an error of 5%.

Keywords: EDM, Precision machining, Tool electrode wear, simulation, error propagation